Country Club Lawn and Tree Specialists

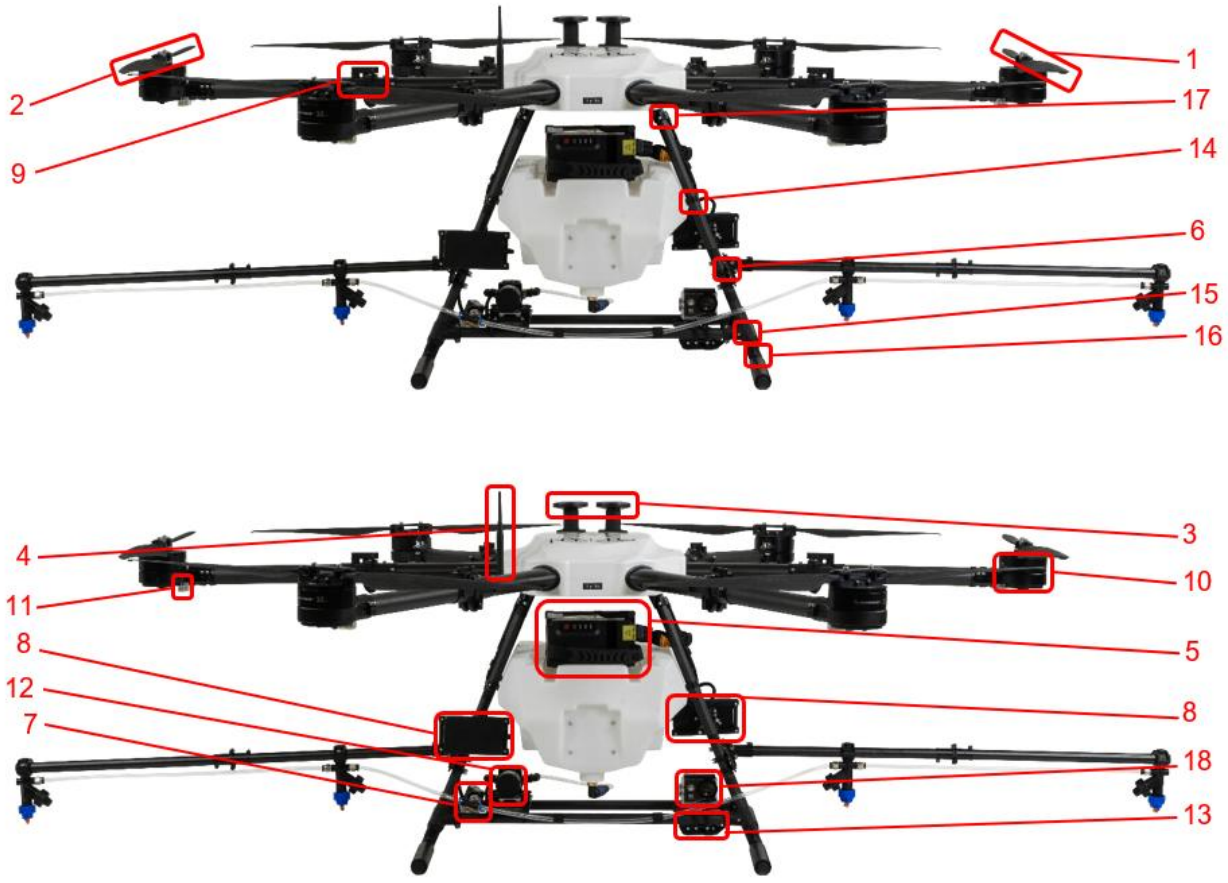
AG-116 Maintenance Manual

Contents

Component Identification

Overview

There are 18 components on the AG-116 which must be identified, excluding the plastic 4.5 Gallon Tank and carbon fiber tubes that constitute the UAS frame.



Description

#	Part	Description	Fasteners		Torque (N*m)
1	Counter-Clockwise Propeller	30x90 inch dual blade. Secure blade with 4mm hex fastener	2	4 mm hex (BLADE)	3.0
			4	2.5 mm hex	2.0
2	Clockwise Propeller	30x90 inch dual blade. Secure blade with 4mm hex fastener	2	4 mm hex (BLADE)	3.0
			4	2.5 mm hex	2.0
3	GPS 1 and GPS 2	Here2 GNSS, STM32F302 microprocessor with IMU and barometer	12	2.5 mm hex & locknut	2.0
4	Ground Station Link Radio Antenna	Interchangeable antenna	n/a	n/a	n/a
5	Battery Connectors and Battery Tray	AS150-u connector	n/a	n/a	n/a
6	Spray Bar Mount 1 and 2	20mm tube mount diameter. Secure spray bars with two m3x10 screws	8	2.5 mm hex & locknut	2.0
			8	2.5 mm hex	2.0
7	Flowmeter/filter	8mm OD press fit tube inlet, 0.3 L/min – 6 L/min flowrate range	n/a	n/a	n/a
8	Obstacle Detection Radar (front/back)	IP67 millimeter wave radar (one on front and rear facing at an angle upwards 5-12 deg)	n/a	n/a	n/a
9	Arm Elbow Joint	Foldable arm joints use spring loaded latch for fast assembly/disassembly	1	3 mm hex & locknut	3.0
			4	3 mm hex	3.0
10	Motor/ESC Assembly	100kv motor with 35mm circular mount	4	3 mm hex	4.5
11	Motor LED	Configurable to any RGB color	2	2 mm hex	1.0
12	Pump	0 – 75 PSI rating, flowrate dependent on nozzle tip	8	2.5 mm hex & locknut	2.0
			4	3 mm hex & locknut	2.0
13	Altitude Detection Radar	IP67 millimeter wave radar	12	2.5 mm hex & locknut	1.5
14	Tank Mount	4 pcs Aluminum tank mount (frame mount)	1	Rivet	n/a
			1	3 mm hex	2.0
15	Cross Beam Mount	4 pcs composite mount for dual horizontal CF beams (frame mount)	3	2.5 mm hex	2.0
16	Foot Mount	4 pcs composite mount for dual horizontal landing gear CF beams (frame mount)	3	2.5 mm hex	2.0
17	Chassis Mount	4 pcs aluminum mount connects chassis to CF tubes of landing gear assembly	2	2.5 mm hex	2.0
18	FPV Camera	GoPro style camera	n/a	n/a	n/a

Daily Maintenance Checklist (POST-FLIGHT PROCEDURE)

Follow these steps for all UAS at the end of each day of spray operation. All cleaning MUST be completed same day to ensure hardware longevity.

STEP 1:	**CLEANING**
1	Clean chemical residue from the inside of the tank and pump system: Pump 1 Gal clean water through the system 3 times Use a degreaser if necessary
2	Clean chemical waste and dirt off drone exterior with a wet rag (a degreaser is recommended to be used) A. Tank B. Frame C. Motors D. Radars E. Propellers F. Pump, flowmeter, and spray bars
3	Remove nozzle tips and nozzle filters from spray bars, soak in water and clean
STEP 2:	**HARDWARE MAINTENANCE**
4	Tighten screws on carbon fiber extension bar mounting plates
5	Inspect GPS bases, Radar mounts, motors, drone base, extension bar/base, and propellers for damage, looseness, or missing screws.
6	Check for leaks in spray system
7	Verify that the propellers are secured tightly and undamaged
8	Verify that all hardware is tightly secured and clean
STEP 3:	**AGROSOL**
9	Connect the drone to AgroSol and go to the maintenance tab
10	Download logs
11	Upload logs
12	Clear logs. If you do not clear logs daily and the AgroDrone accumulates over 100 flight logs, AgroSol will have difficulty downloading logs until they are cleared
13	Perform the compass calibration (Every 3 months, if drone begins to fly poorly, if drone is moved more than 50 miles, or drone is near an area of significant magnetic interference). Do not calibrate near large metal objects: buildings, vehicles, power lines
STEP 4:	**TOOL-KIT**
14	Check spray team's Tool-Kit for any broken or missing parts

Maintenance Schedule

Inspection Schedule

Regularly inspect each part based on flight hours. Flight hours are automatically tracked internally on each UAS and can be viewed in the AgroSol Maintenance Tab. In the event of a crash, perform an inspection of all parts before resuming operation.

Part	**# Flight Hours**
Propeller (CCW/CW)	10
Rotor (CCW/CW)	20
Ground Station Link Radio Antenna	10
Battery Connector (as150u)	20
GPS	10
GPS Mast	10
Obstacle Detection Radar	20
Altitude Detection Radar	20
Flowmeter Unit	20
Flowmeter Accuracy	10
Pump	20
Pneumatic Spray System Tubing	10
Nozzles	10
4.5 Gallon Tank	10
Spray Bar Mount	20
35 mm Carbon Fiber Tubes (Arms)	20
Arm Elbow Joint	10
20 mm Carbon Fiber Tubes (Legs)	20
20 mm Carbon Fiber Tube Mounts (Legs)	20
Plastic Shell	20
Internal Components	20
Frame Mounts	20

Inspection Criteria

If the part does NOT pass the listed criteria upon inspection, replace/repair part immediately. As a part of the inspection for each part, check for tightness of all fasteners listed for that part in the component identification description. Check for tightness to the listed torque.

Part	**Inspection Criteria**
Propeller (CCW/CW)	- No cracks or chips larger than 0.1-inch radius - Propeller blade level with arm - M3x12 mount screws tight and rust free - 4mm hex screw tight and rust free
Rotor (CCW/CW)	- No rattling or scratching noise when spun by hand - No large dents or cracks in rotor housing - LED mount screws tight - Rotor guard mount screws tight
Ground Station Link Radio Antenna	- Antenna casing structurally intact - Antenna screwed in tight to antenna mount (comes loose often) - Antenna mount nut screwed in tight on plastic shell
Battery Connectors	- No signs of wear or distress on wires from connectors into frame (inspect closely right where wires enter frame)
GPS	- Correct LED indicator colors when powered on - GPS secured straight and tight to mast (Double sided tape OK) - GPS housing and wire not damaged (check closely at mount points and where wire enters frame) - Acceptable GPS accuracy performance - GPS does not frequently give errors in AgroSol
GPS Mast	- Top of mast level to drone - All screws tight and rust free - Mast parts not cracked/damaged
Obstacle Detection Radar	- Radar housing intact - Radar wire not damaged (check closely at mount points and where wire enters frame) - Unit does not heat up when powered on
Altitude Detection Radar	- Radar housing intact - Radar wire not damaged (check closely at mount points and where wire enters frame) - Unit does not heat up when powered on - Acceptable altitude readouts in AgroSol
Flowmeter Unit	- Flowmeter housing intact - Acceptable flowrate readouts in AgroSol - Flowmeter wire not damaged (check closely at mount points and where wire enters frame)
Flowmeter Accuracy	- Flowrate performance during flight (gal/ac output) should be within 2%, or 5% in the worst case - Set a constant test flowrate and measure output over 1 minute

	using a graduated cylinder, actual flowrate should match desired - If flowrate is not to desired accuracy, perform the flowmeter calibration as described in the software manual
Pump	- Pump housing intact - Acceptable maximum pump pressure performance (maximum pressure output will decline over time) - Pump wire not damaged (check closely at mount points and where wire enters frame)
Pneumatic Spray System Tubing	- No leaks in tubing when spraying at max pressure - Tubing clean of chemical residue
Nozzles	- No leaks when spraying at max pressure - No cracks in plastic nozzle body - Internal filter clean and undamaged
4.5 Gallon Tank	- No leaks when tank is full (check tank outlet) - No cracks or damage to plastic (check 4 mount points)
Spray Bar Mount	- No cracks or chips in carbon fiber plate or aluminum tube mount - All screws tight and rust free
35 mm Carbon Fiber Tubes (Arms)	- No visible cracks in carbon fiber tubes - All screws tight and rust free
Arm Elbow Joint	- No cracks (can crack when CF mount screws overtightened) - No left-right “wobble” (tighten clasp/hinge M4 screws to fix) - All screws tight and rust free
20 mm Carbon Fiber Tubes (Legs)	- No visible cracks in carbon fiber tubes - All screws tight and rust free
20 mm Carbon Fiber Tube Mounts	- No visible cracks or damage on any mount (4 each of 4 mount types: frame mount, tank mount, horizontal 20 mm tube mount, 20 mm foot tube mount) - All screws tight and rust free
Plastic Shell	- Shell fastener screws tight and rust free - Shell closes evenly on all sides (sides seal shut) - No large cracks or visible damage
Internal Components	- Take off plastic shell top: inspect inside center frame for damage - All connectors plugged in tight - No loose dangling wires - No signs of damaged components or electrical shorts
Frame Mounts	- Inspect all 4 of each tank mount, cross beam mount, chassis mount, and foot mount - Check for cracks in mount material - Check for fastener tightness according to component identification specification

Safety

Safe Maintenance Guidelines

1	Never perform maintenance cleaning procedures with the batteries inside the drone, even if the batteries are disconnected.
2	Always wear appropriate personal protective equipment when cleaning with chemicals.
3	Always communicate with the spray team about potential safety or maintenance concerns before beginning maintenance procedures.
4	Always be aware of the GPS LED indicator lights and buzzer sounds. They will indicate the safety status of the drone.
5	Always follow safe battery charging and storage procedures.

Warning Signs

1	Smell or appearance of electrical smoke from center frame or motors. This occurs when there is an electrical short in the system.
2	Visual wear on any wire housing. Can cause electrical short if left to degrade over time.
3	Any components or wires getting hot when powered on, aside from motors after flight. This occurs when there is an electrical short in the system.
4	Permanent discoloration of aluminum parts and spray tubing, or excessive rust. This occurs when the UAS is not cleaned properly after spraying corrosive compounds.
5	Frame “wobble” when placed on flat ground. Occurs when frame screws are loose.
6	Arm “wobble” at the elbow joint. Occurs when M4 Elbow Joint Pivot screw is loose. Can cause dangerous vibrations during flight.
7	Inconsistent flowmeter readings. Occurs when dirt gets inside the flowmeter housing, or when flowmeter cables are loose.

Ground Testing

When to Ground Test

Follow ground testing checklist after any of the following events:

- Crash
- Unknown issue stops user from flying

Ground Test Steps and Checks

1) Place drone outside in a location 15 feet from any obstacle, where it can spray and spin its motors without issue
2) Put exactly 1 gallon of fluid in tank(s). Check for any leaks
3) Take a pair of batteries, measure the voltage, and connect to drone
4) Open AgroSol and connect to the drone over RFD. Verify RFD connection works
5) Spray out tank using constant flowrate
6) While spraying, check for any leaks in the spray system
7) Check battery voltage on AgroSol, if off by over 0.2V recalibrate voltage
8) Check for correct radar altimeter reading. Pick up drone and move it around to confirm the altimeter reading changes as expected
9) Turn on TX. Change flight modes. Check that flight mode changes in AgroSol operations tab as expected
10) Upload a mission. Check mission uploads on first try without issue
11) Check that GPS gets a lock (indicator in operations tab on drone card)
12) Arm motors. DO NOT TAKE OFF. Check that all motors spool up and rotate in the correct CW/CCW direction. Check for errors on arming. If any propellers were replaced, double check the correct CW/CCW propeller is on the respective CW/CCW motor
13) Disconnect batteries
14) Connect drone to laptop using direct USB connection. Check that connection works and logs can be downloaded

Flight Testing

When to Flight Test

Follow ground testing checklist after any of the following events:

- Crash
- Unknown issue stops user from flying

Flight Test Steps and Checks

1) Take drone outside to a safe and open testing field
2) Perform compass calibration
3) Fly the drone manually: take off, test moving left right forward back, test yaw, land drone
4) Upload a safe standard testing mission. This mission should be verified safe and low altitude by flights on another drone that is confirmed to fly well. This mission should be no more than an acre. Ensure the Ferry altitude, RTL altitude, and spray altitude are each separated by at least 10 ft. Upload mission with 0 pump power. Check that the mission uploads on the first try. Check that the mission appears in the operations tab as uploaded
5) STRICTLY FOLLOW PREFLIGHT CHECKLIST
6) Arm motors. Check that all motors spin up in the right CW/CCW direction
7) Take off. Check that drone takes off to correct Ferry altitude. Check the motors are not making any unusual noises. Check the drone appears to fly stable
8) As the drone descends to the mission area, check that it yaws to face the mission line direction within acceptable error, (recalibrate compass if not)
9) Check that the drone flies stable during the spray section of the mission, check the drone reaches speeds as set on the spray mission.
10) RTL mission. Check that RTL works, drone climbs to correct RTL altitude (within a few feet)
11) When the drone returns to descend for land, check that the land looks stable and controlled.
12) Fill the tank(s) with 1 gallon of fluid. Upload a mission using dynamic flowrate that will spray 0.75 gallons over the entire mission. Follow steps 4-7 again.
13) Let the drone finish the mission, and measure the remaining volume in the tank. Recalibrate flowmeter if off by more than 5%
14) Swap batteries. Perform one final flight with a full tank. Adjust the mission dynamic flowrate to spray the full tank over the mission area AND RUN EMPTY. Turn on empty tank RTL. Use the Toolbox calculator to ensure a slow enough speed is selected. Fly fast enough to ensure the drone can complete mission. Follow steps 4-7 again.
15) Verify the drone RTLs when the tank is empty. Verify the total volume sprayed in AgroSol matches what was sprayed.